Executive Summary

The restructuring of the utility industry has created new opportunities for the generation and use of electrical power. Distributed generation (DG) has emerged as a desirable alternative to purchased power for many applications. DG consists of relatively small generating units (typically less than 30 MWe) located at or near consumer sites to meet specific customer needs, to support operation of the existing power grid, or both. DG units can provide incremental capacity at relativity low capital cost and can be brought online in a fraction of the time required to expand or build new central power systems.

This CD is targeted for use by key decision-makers in municipalities, industrial firms, medical complexes, and commercial establishments who are considering the addition of distributed generation (DG). The purpose is to provide a sufficient background for the decision-maker to better evaluate the options, market considerations, drivers and issues related to successful use of DG. Additionally, it provides an overall approach to the relevant issues to be considered, including a discussion of the key steps and issues that relate to implementing successful projects. Web based information sources are included with appropriate links.

Incorporating DG to provide electricity, light, heat, or mechanical energy at the point of use offers the following advantages:

- DG eliminates the need for costly installation of new transmission lines, which frequently become entangled in environmental controversy.
- DG reduces energy delivery losses resulting in the conservation of vital energy resources.
- DG expands the use of renewable resources, such as biomass cogeneration in the lumber and paper industry, rooftop solar photovoltaic systems on homes, and windmills to further improve energy resource conservation.
- It improves use of traditional energy in devices such as natural gas micro-turbines (see www.clean-power.com) and fuel cells (www.fe.doe.gov/coal_power/fuelcells/index.shtml) providing increased generation energy efficiency to reduce operating costs, pollutants and resource consumption rates.
- DG eliminates potential brown-outs or black-outs caused by utilities' reduced margin of generation reserve capacity in certain areas of the country.

The technology innovations for the successful implementation of distributed generation systems have been realized and can be added to buildings and other settings with only a minimum disturbance to the existing landscape.

Figures 1 and 2 are examples of field installed distributed generation systems. The first of these shows a phosphoric acid fuel cell (PAFC) DG system located in New York City's Central Park. This ONSI Corporation PC 25 unit generates 200 kW and is one of nearly 200 units located in the United States and overseas.

Figure 2 shows on of three 50-kilowatt AOC 15/50 wind turbines built in the Arctic tundra near Kotzebue, Alaska. Kotzebue is Alaska's largest Eskimo community north of the Arctic Circle, with about 3,500 residents.

Figure 1. ONSI Fuel Cell Installation

Figure 2. Arctic Wind Turbine Installation

In general most of the key barriers preventing the widespread implementation of DG, can be classified into the following three categories:

- Regulatory barriers
- Financial barriers
- Environmental issues.

The major regulatory issue is recovery of stranded costs by utilities. Currently, these costs are being recovered via a fee on future electricity sales or imposed as a charge on those individuals or businesses exiting the utility system. To date, Massachusetts is the only state to address this issue, whereby proposing that if a proposed DG system exceeds 50% efficiency then the withdrawal fee is waived. A second key regulatory issue is interconnection with the grid. Currently, interconnection requirements vary from utility to utility and from state to state. The proposed interconnection of each DG installation is subject to review by the local utility. A fee is charged for this service even if a decision not to proceed with the project is reached at a later date. An IEEE committee is working on this issue via the development of a standard (P1547) for DG interconnections (see www.ieee.org).

Principal financial barriers include the lack of current utility tariff and pricing practices for accommodating DG systems, the status of current business models with regard to DG systems, and the impact of current monopoly regulations. Pricing practices, as a rule, do not properly account for distribution service benefits that can be derived from DG. Also, more appropriate tariffs would provide standby and backup power services without prohibitive charges. Current business practices and models were established to accommodate vertically integrated utilities and, as such, ignore the benefits of DG. Examples of pricing practices favoring utilities include such benefits as T&D upgrades, providing power for ancillary services, and for improving system reliability, power quality and reducing line losses. Since monopoly regulations provide no reward to utilities for energy-efficiency savings, state and federal regulations are needed to produce more competitive markets, for example, providing incentives for use of waste heat. For more information on regulations, regulatory issues, and licensing needs click here.

In the environmental arena, the main topic of concern relates primarily to site-specific concerns, such as zoning, permitting, and environmental plan approval. The need to update current regulations in order to streamline the permitting process is fundamental. This would accelerate the introduction of new facilities.

Distributed generation will play an increasingly important role in meeting our nation's needs for additional electrical power. The United States electricity consumption increased 21.5 percent from 1990 to 1999. The Energy Information Agency projects that world's electricity consumption to increase by two-thirds from 1999 to 2020. Domestically, new demand combined with plant retirements is projected to require as much as 1.7 trillion kilowatt-hours of additional electric power by 2020, almost twice the growth of the last 20 years. Over the next decade, the domestic distributed generation

market, in terms of installed capacity to meet the demand, is estimated to be 5-6 gigawatts per year. Worldwide forecasts show electricity consumption increasing from 12 trillion kilowatt hours in 1996 to 22 trillion kilowatt-hours in 2020, largely due to growth in developing countries that lack nationwide power grids. The projected distributed generation capacity increase associated with the global market is conservatively estimated at 20 gigawatts per year over the next decade. Table 1 (see www.distributed-generation.com) shows the size of several markets for distributed generation. These projections are sales estimates through 2010.

Table 1. Sales Estimates for Selected Markets through 2010

Market Sector	Market Application	Capacity (MW)	Number of DG Units (thousands)
Industrial	Continuous Power	900	3
	Combined Heat and Power	9,000	35
	Peak Shaving	500	2
	Standby/Emergency	5,000	100
	Premium Power	8,000	30
Commercial	Standby/Emergency	15,000	300
	Premium Power	30,000	600
Residential	Fuel Cells	3,500	500

In order to meet these projected demands, the U.S. Congress appropriated $18 million in fiscal year (FY) 1993 to advance the use of phosphoric acid fuel cells (PAFCs) at Department of Defense (DoD) installations. An additional $18.75 million was appropriated in FY94 to expand the program. The U.S. Army Construction Engineering Research Laboratory (USACERL) was assigned the mission of managing the Fuel Cell Demonstration Program for the DoD. USACERL's specific tasks included developing turnkey PAFC packages, devising site criteria, screening DoD candidate installation sites against selection criteria, evaluating viable applications at each candidate site, coordinating fuel cell site designs, installation and acceptance of the PAFC power plants, and performance monitoring and reporting. For site performance information, click here.

The U.S. DOE continues to lead the power generation industry in the development of innovative technology, such as fuel cells, that has propelled distributed generation to the front of the energy arena. DOE is leading this program through a partnership with other federal agencies, state governments, technology suppliers, industry research organizations, academia, power generators, energy service companies and end users.

The Department of Energy's distributed generation program is divided between the Fossil Energy and Energy Efficiency and Renewable Energy. The research and programs are

implemented through National Labs, academia, and technology developers. For information on the Department of Energy's distributed power and power generation technologies, click onto the following web sites:

- Fossil Energy: www.fe.doe.gov/programs_coalpower.html
- National Energy Technology Laboratory: www.netl.doe.gov/
- Office of Energy Efficiency and Renewable Energy: www.eren.doe.gov/
- National Renewable Energy Laboratory: www.nrel.gov/st.html

Distributed generation is being promoted strongly be several organizations from the private sector. Notably, the American Public Power Association (See www.appanet.org) has been very active in promoting DG projects for public power. Organizations such as Public Technology Inc. (See www.pti.nw.dc.us) have been working with local municipalities to educate and assist them in defining the benefits of using DG. Furthermore, energy companies such as Austin Energy (See www.austinenergy.com) have been leaders in implementing DG projects. The combined efforts of government and the private sector will pave the way for the realization of a large economical market for DG.

This document, prepared under support by the DOE National Energy Technology Laboratory, provides abundant information that developers can use when planning their distributed generation plant. For example, there are 44,000 state and local code jurisdictions in the United States, and a lack of national codes and standards adds to the time and cost associated with the siting and permitting of distributed generation facilities. Many distributed generation facilities are too small to be governed by the siting requirements of many states, while requiring that regional permitting requirements and building and fire codes be considered. Local air emissions, noise, aesthetics, and land use regulations are issues that every developer will have to be concerned with when sitting new distributed generation installations. Quite often, developers have limited resources to gather information and lack the necessary tools to evaluate the difference between new systems. This document provides a summary of the organizations experienced with local and regional codes and standards, as well as their web site URL for additional information. Examples include the American National Standards Institute (click here) and the National Fire Protection Association (click here). Finally, this document also summarizes several commercially available computer models that evaluate distributed generation systems; reviews implementation requirements and discusses opportunities and threats for potential users. An example of an available computer model can be found at http://www.archenergy.com/.